

Introduction to the Atmosphere

Chapter 3

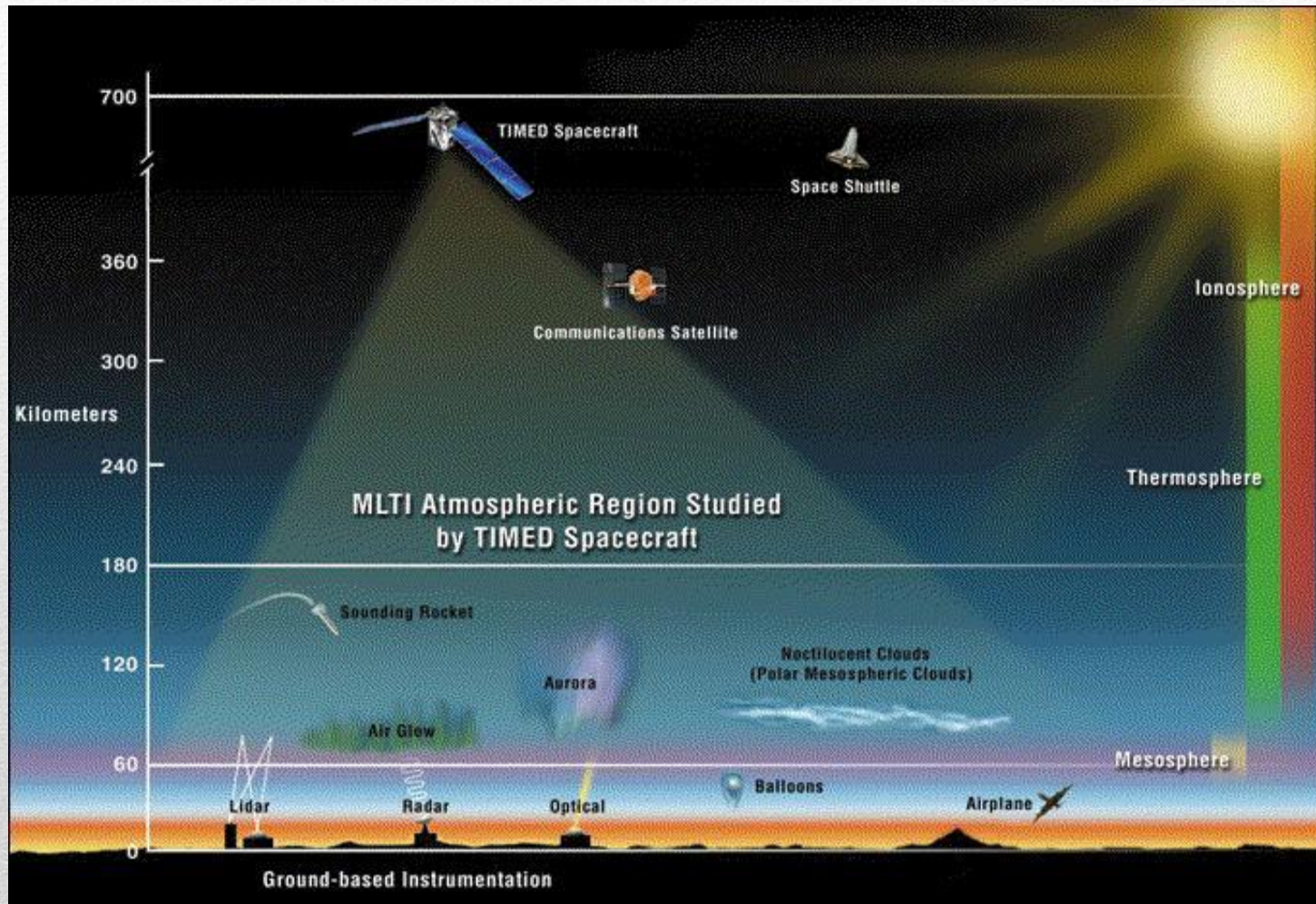
Atmosphere, Weather and Climate

- General Composition of the atmosphere
 - **Temperature**
 - **Pressure and Wind**
 - **Moisture**
 - **Flows and Disturbances (Weather)**
 - **Zones and Types (Climate)**
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Size of the Earth's Atmosphere

- **Extends outward at least 6000 miles**
 - **More than half of the mass of the atmosphere found below 3.8 miles**
 - **More than 98% lies within 16 miles of sea level**
 - **Humans are creatures of the atmosphere**
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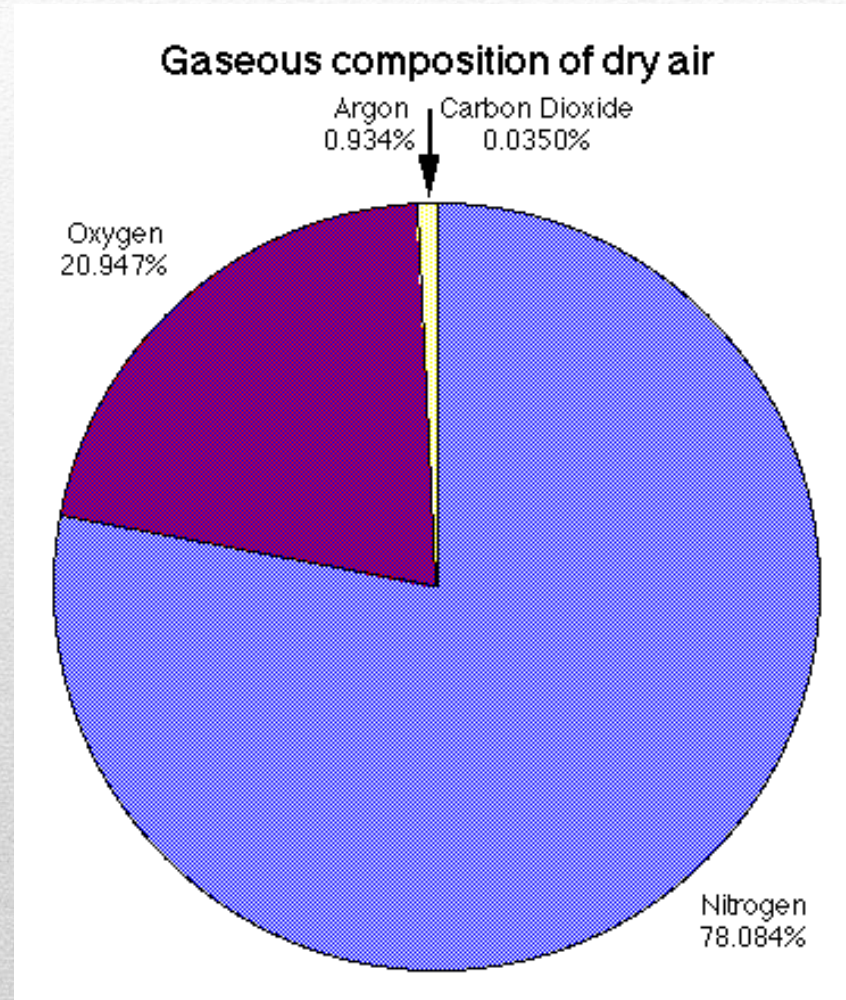
Size of the Atmosphere



What is the composition of the Atmosphere

- Permanent Gases
 - **Nitrogen and Oxygen make up the 99 % of the atmosphere**
 - 78% Nitrogen
 - 21% Oxygen
 - Other 1%
 - Argon .9%
 - Carbon Dioxide .038%
 - All other gases .06% equaling .998%
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Gaseous Composition of Dry Air



Other Significant Gases

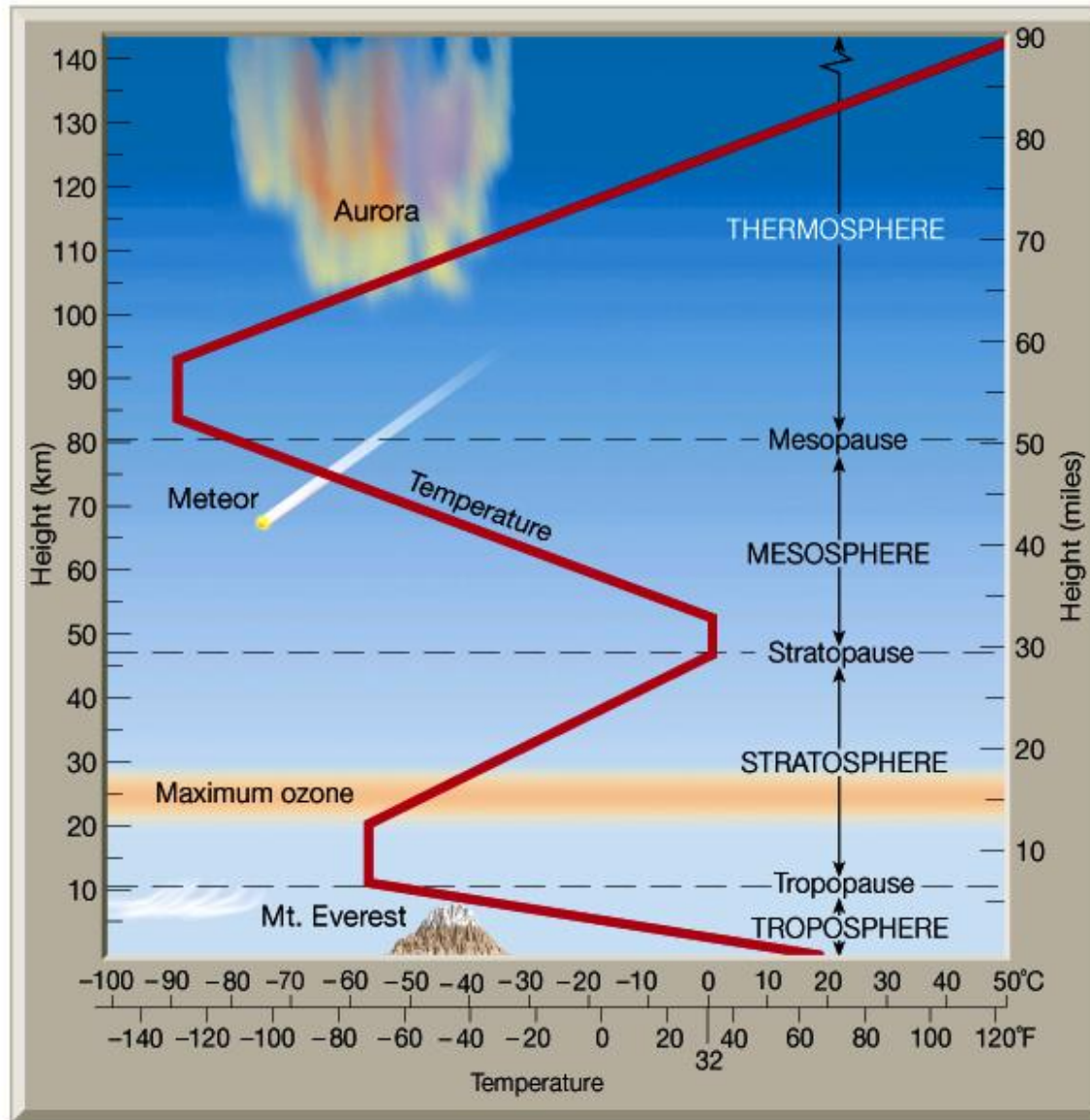
- **Water Vapor**
 - **Invisible**
 - **Visible**
 - **Clouds**
 - **Precipitation (liquid or solid)**
 - Abundant in air overlying warm, most surface areas, like **tropical oceans** measuring up to as much as **4% of the volume of the air mass**
 - Over **deserts or polar regions** it would make up **less than 1% of the volume**.
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Other Significant Gases

- **Carbon Dioxide (CO₂)**
 - **Significant to the climate because of its ability to absorb infrared radiation**, which helps warm the lower part of the atmosphere
 - **Distributed evenly throughout the lower atmosphere**
 - **Increasing during the last century at a rate of about .0002 percent.**
 - **Increased levels of Carbon Dioxide are causing the lower atmosphere to produce somewhat unpredictable climate changes (global warming)**
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Other Significant Gases

- Another **minor vital gas** in the atmosphere is **Ozone**
 - Mostly **concentrated in the Ozone layer**.
 - Between **9 to 30 miles above sea level**
 - **Ozone is excellent as an absorber of ultraviolet solar radiation** and its deadly effects.
 - Other **variable gases** include
 - **Carbon monoxide, sulfur dioxide, nitrogen oxides, and various hydrocarbons.**
 - All hazardous to life and may possibly effect the climate
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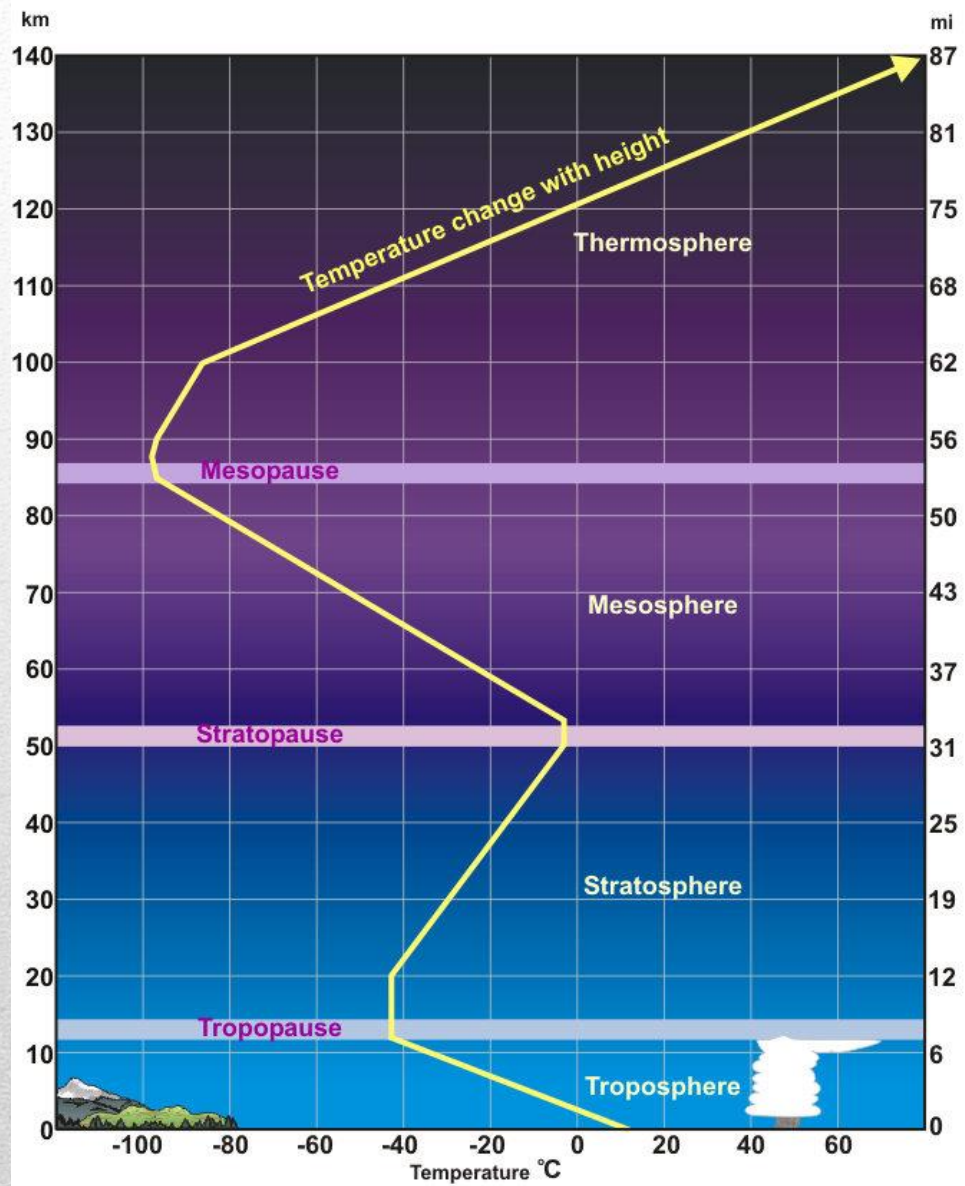


Particulates (Aerosols)

- **Large nongaseous particles in the atmosphere**
 - **Mainly liquid water and ice**
 - **Clouds, rain, snow, sleet, and hail**
 - **Dust particles large enough to be visible, but too heavy to fall to the ground**
 - **Smaller particulates are invisible to the naked eye, may also be suspended in the atmosphere**
 - **Found near their origin, either urban areas, or the natural condition that caused the particulate**
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Affects on Weather and Climate

- 1. Many of the **particulates are hygroscopic (absorbs water)**.
 - The **water vapor condenses around the particulates as they float by**.
 - **Accumulation of water vapor molecules is a critical step in cloud formation**.
 - 2. **Some either absorb or reflect sunlight, thus decreasing the amount of solar energy that reaches Earth's surface**.
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Vertical Structure of the Atmosphere

- Thermal layers of the atmosphere
 - Troposphere and Tropopause
 - Lowest level, closest to sea level
 - 11 miles at equator to 8 miles at poles
 - Deepest over the tropical regions
 - Shallow over the poles
 - Varies with the passages of warm and cold air
 - Stratosphere and Stratopause
 - Extends from 11 miles above sea level to 30 miles above sea level
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Upper Thermal Layers

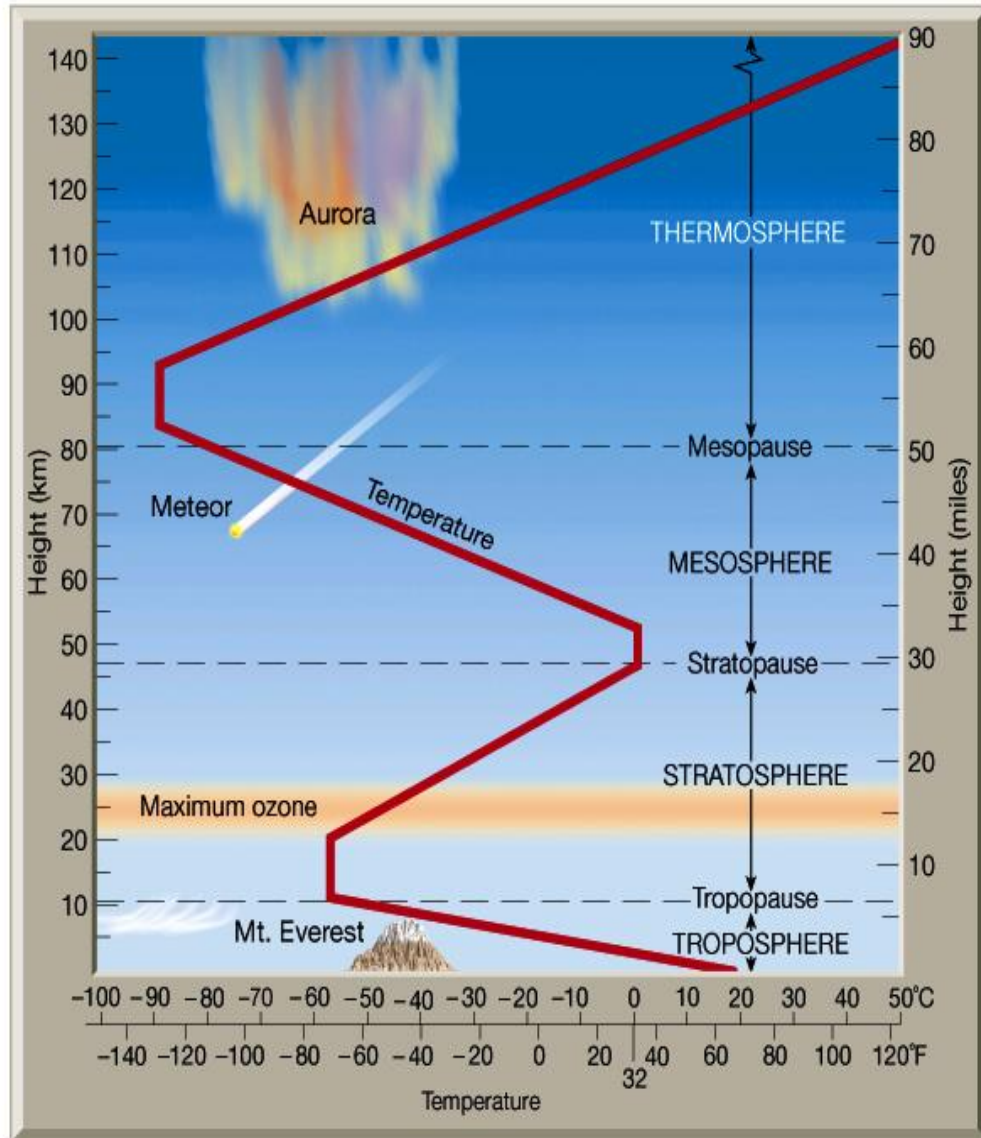
- Mesosphere and Mesopause
 - Begins 30 miles and ends 50 miles above sea level
 - Thermosphere
 - Begins at 50 miles and gradually extends out
 - Exosphere
 - Outer most portion of the atmosphere
 - Blends with interplanetary space
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Temperature of the Atmospheric Layers

- **Troposphere:**
 - The temperature **decreases** with the increase of altitude
 - Average temperature is 59° at the surface
 - Average temperature at the top -71°
 - **Tropopause:** Several miles where the top temperature stays constant
 - **Stratosphere:**
 - The temperature **increases** with the increase of altitude
 - 20 miles above sea level to 30 miles the temperature rises
 - Average temperature at the top 28°
 - **Stratopause:** Several miles where the top temperature stays constant
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Temperature of the Atmospheric Layers

- **Mesosphere:**
 - 30 miles above sea level to 50 miles the temperature **decreases**
 - Average temperature at the top -80°
 - **Mesopause:** Several miles where the temperature stays constant.
 - **Thermosphere:**
 - Temperature **increases** to an altitude of 125 miles about sea level
 - **Exosphere:**
 - Outer layer of the atmosphere
 - **No concept** of temperature
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Warm Zones/Cold Zones

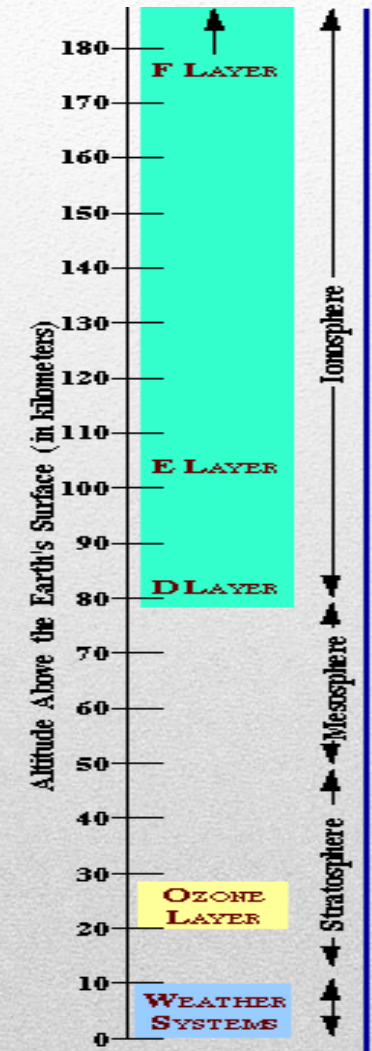
- **“Warm Zones”**
 - Zone that has a specific source of heat
 - **Troposphere:**
 - The surface of the Earth is the source
 - **Top of the Stratosphere:**
 - The Ozone layer is absorbs ultraviolet rays ,
thereby warming the atmosphere
 - **“Cold Zones”** are areas that simple don’t have the warming sources
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Pressures

- Atmospheric pressures are simply the “weight” of the overlying air.
 - The taller the column of air the greater the pressure.
 - So at sea level, the column of air above is longer thus the air pressure is higher, and the air is denser
 - At a high altitude there is a smaller column of air, so the air pressure is lower and the air is less dense.
 - The decrease in air pressure decreases with altitude but not at a constant rate.
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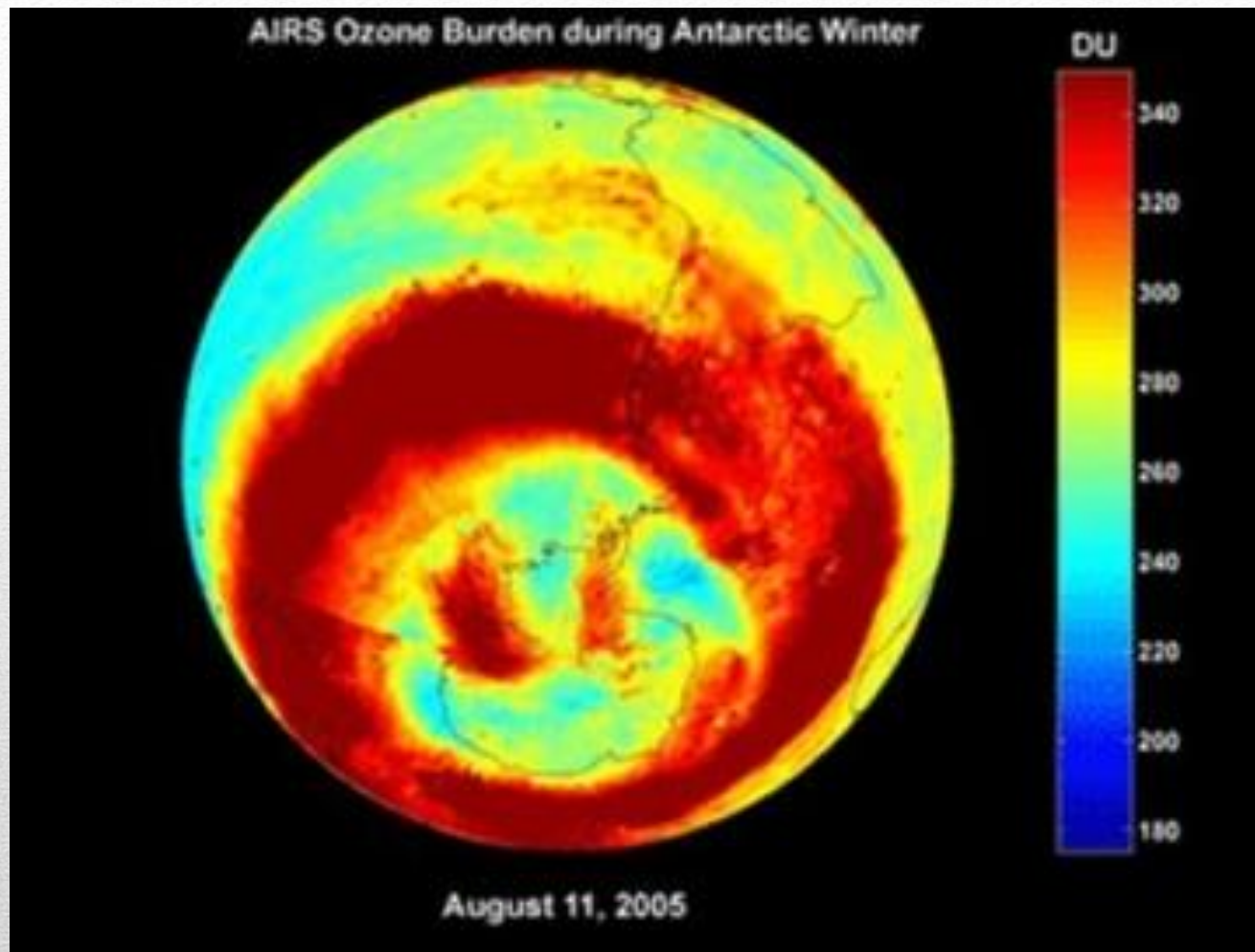
Two other Vertical Compositional Layers

- Ozonesphere
 - 9 to 30 miles above sea level
 - Gets its name because the **concentration of ozone is at its highest**
 - Found in the Stratosphere
- Ionosphere
 - 40 to 250 miles above sea level
 - Deep layer of electrically charged molecules and atoms
 - Aids in the **reflecting of radio waves back to earth**
 - Is also known for its *auroral displays* or the **Northern Lights**.
 - Found in the Thermosphere



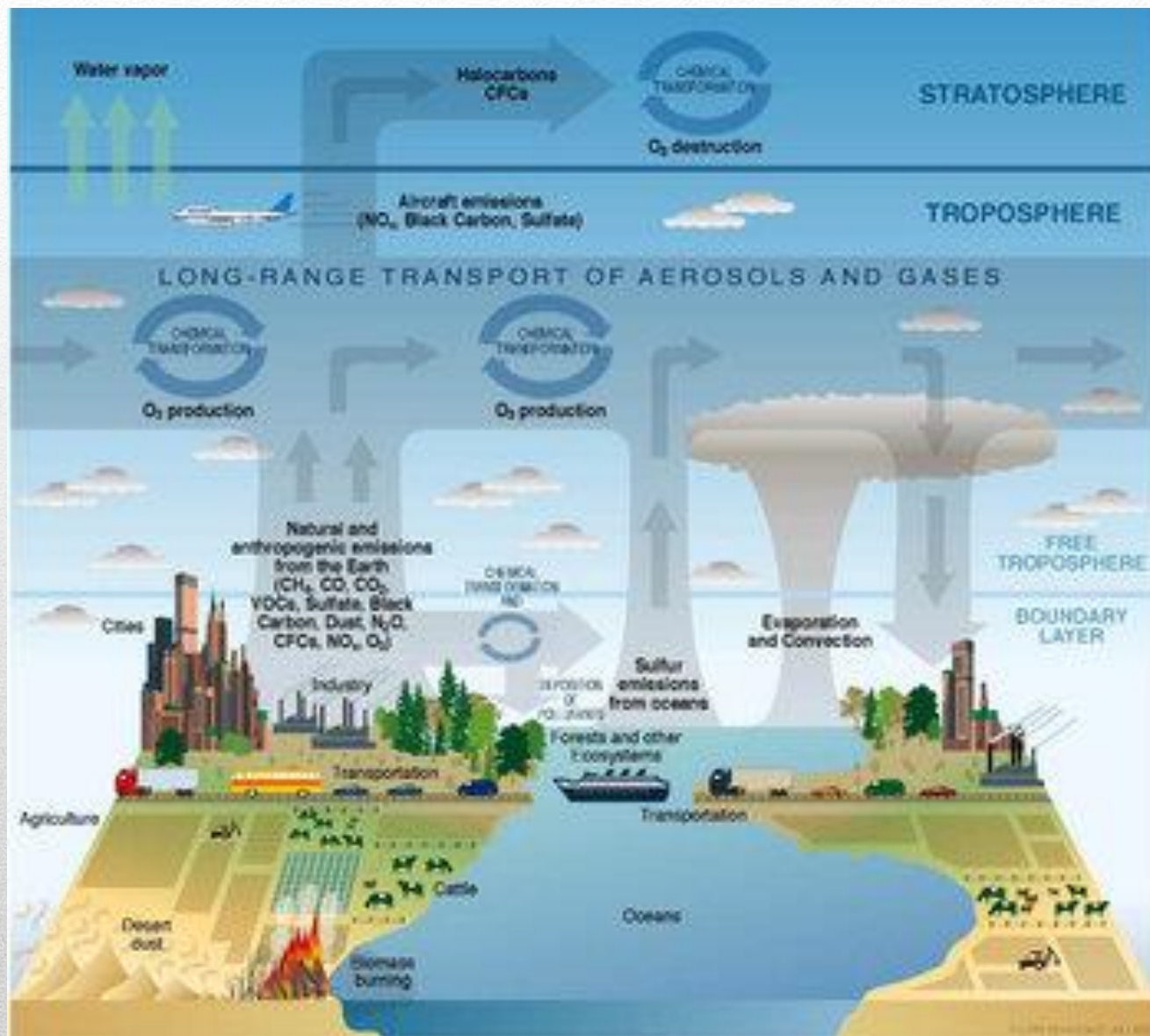
Human-Induced Atmospheric Change (What have we done?)

- **Depletion of the Ozone Layer**
 - **Hole in the Ozone Layer**
 - **Chlorofluorocarbons most problematic chemicals used by humans that depleted the Ozone.**
 - **Thinning of the Ozone Layer allows for Ultraviolet rays to reach the surface of the earth**
 - **In the polar areas (Antarctica), the ice crystals form a place for chlorine based molecules to form. In the spring they trigger a catalytic reaction and the Ozone is depleted even more than in the other latitudes.**
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Air Pollution

- Smoke
 - Sulfur Compounds
 - Nitrogen Compounds
 - Photochemical Smog
 - Consequences of Anthropogenic Air Pollution
 - Damages our health
 - Damages the plant life
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Weather and Climate

- Weather...
 - Short-run atmospheric conditions that exist for a given time in a specific area.
 - The sum of temperature, humidity, cloudiness, precipitation, pressure, winds, storms, and other variables for a short period of time
 - Weather is in an almost constant state of change
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Weather and Climate

- Climate.....
 - The generalized variations of the weather
 - The aggregate of day-to-day weather conditions of a long period of time.
 - Has averages, variations and extremes
 - Weather and Climate have direct and obvious influences on agriculture, transportation, and human life, and the physical land.
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Four Elements of the Weather and the Climate

- **Temperature**
 - **Moisture content**
 - **Pressure**
 - **Wind**
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Controls of the Weather and Climate

- Latitude
 - Distribution of Land and Water
 - General Circulation of the Atmosphere
 - General Circulation of the Oceans
 - Altitude
 - Topographic Barriers
 - Storms
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The Coriolis Effect or Force

- **Appearance of all things drifting sideways** as a result of the Earth's rotation.
 - Why? If a rocket is shot directly at New York, by the time the rocket arrives at New York, the Earth has rotated and the rocket seems to have “**drifted**”
 - **Applies to any freely moving object.**
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The Coriolis Effect

Caused by the earth's rotation



Objects deflect to
the right in the
Northern hemisphere

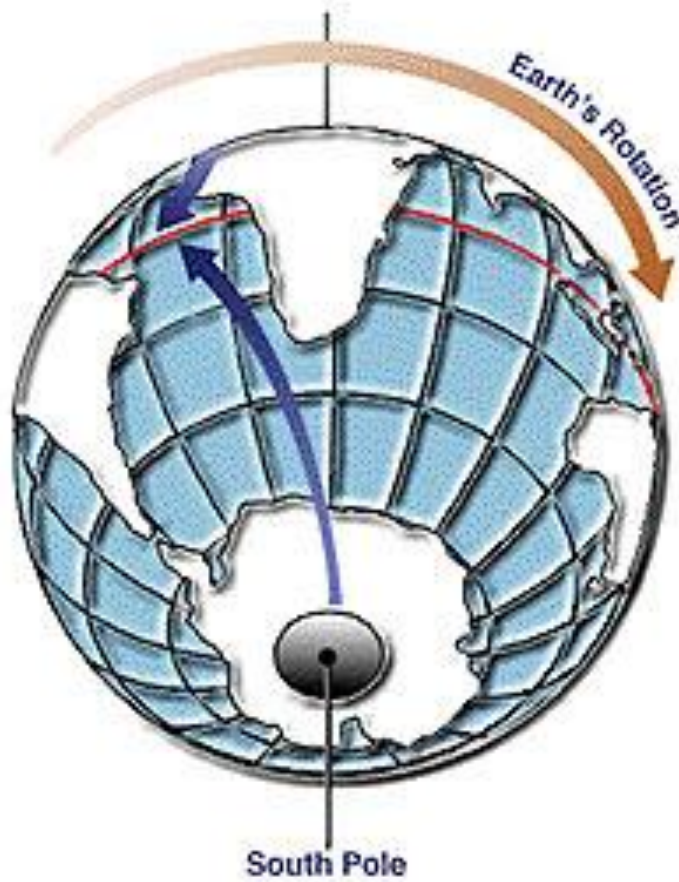
Objects deflect to
the left in the
Southern Hemisphere

Four Basic Points of the Coriolis Effect

- 1. **Regardless of the initial direction of motion**, any freely moving object appears to deflect to the **right** in the **Northern Hemisphere** and to the **left** in the **Southern Hemisphere**
 - 2. The apparent deflection is **strongest** at the **poles** and **decreases progressively toward the equator** where there is zero
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Four Basic Points of the Coriolis Effect

- 3. The Coriolis effect is proportional to the speed of the object, so a **fast-moving object** is **deflected more than a slow one**
 - 4. The Coriolis effect influences direction of movement only... it has **no effect on speed**.
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Southern Hemisphere



Northern Hemisphere

Major importance of the Coriolis Effect

- All winds are affected by the Coriolis Effect
- Ocean currents are also deflected by the Coriolis Effect
- The Coriolis Effect may or may not effect the direction of the flow of the water as it drains down the sink.

